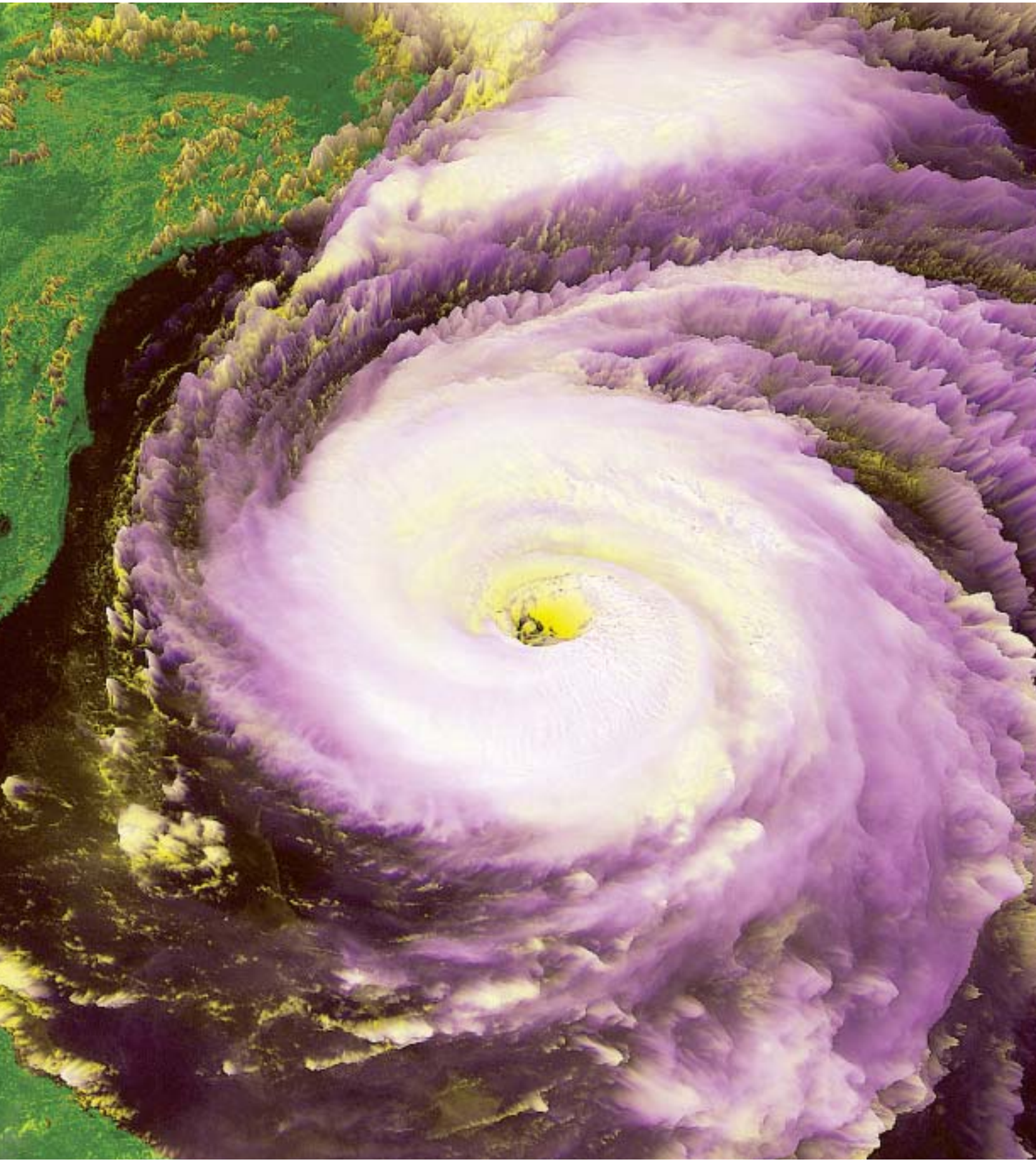
# SCHEDULING IN THE REAL WORLD

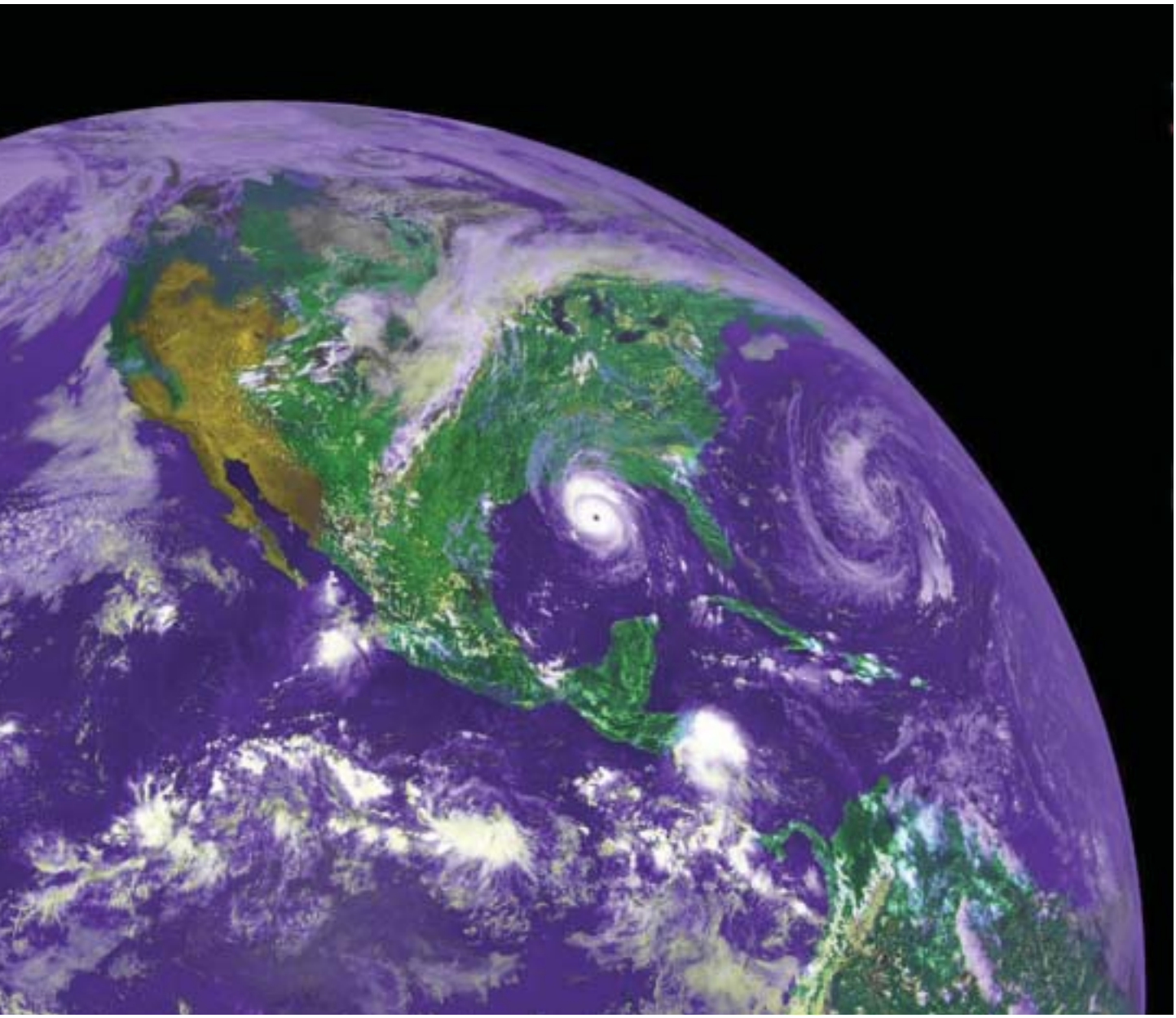
BY MARTY DAVIS

A DECADE AGO WHEN I CAME TO THE GEOSTATIONARY Operational Environmental Satellite (GOES) program, we had one limping spacecraft, plus a satellite rented from the Europeans. I had to start by assuming, essentially, that we had no resources in orbit.

GOES is by no means an inconspicuous program. Every night when you watch the weather on the evening news, you see GOES satellite pictures. My customer, the National Oceanic and Atmospheric Administration (NOAA), requires two operating satellites, with a spare ready to be put into operation when an existing satellite goes out of service. Clearly, we needed to build our first two satellites and get them launched as fast as we could. There was money available, and a contractor lined up to do the work. Easy so far, from a scheduling point of view: Build the spacecraft and launch it.

**Keeping an eye on the storm:**
GOES weather satellites capture an image of Hurricane Fran as it begins its destructive journey north along the East Coast in 1996.





But what do you do when events beyond your control dictate when you launch a spacecraft?

Back in those days the people who built launch vehicles were doing a lot of launches. Thus, we expected long launch queues. The idea of launching a spacecraft the moment it was needed didn't seem very realistic. In addition, storing a backup for extended periods of time seemed too risky. There were certain detectors that we couldn't check at room temperature; we would have to go back in the thermal vacuum chamber. How long could we have a spacecraft out of thermal vac and still have confidence that it would work when launched? We didn't know, and it made us nervous to think about putting things in storage for two or three years, then trying to get hold of a thermal vac chamber, then hoping to fit into a launch queue.

So, I sold my customer on the idea of having an on-orbit spare. That meant I could build the third spacecraft and launch it as soon as it was ready. We built the first two as fast as we could, and then tailored the third one to when we wanted it to pop out and get ourselves in the launch queue. Thus far, we are still talking about a fairly easy scheduling scenario.

We assumed one failure out of every five spacecraft; one of the five satellites budgeted was for insurance. In the end, all five succeeded. We never had that launch or spacecraft failure. The second spacecraft had trouble with a momentum wheel and we took it out of service after three years—two years short of its expected operational lifetime. On the other hand, the one we launched in 1994 still operates.

## WATCHING THE WEATHER

Flash floods, hail storms, tornadoes, and hurricanes—all severe weather conditions worth keeping an eye on. Since 1975, NASA has produced that eye for the National Oceanic and Atmospheric Administration (NOAA). NASA's latest series of geostationary operational environmental satellites (GOES) provide high spatial and temporal resolution images from a vantage point of 22,300 miles above the earth, as well as full-time temperature and moisture profiles of the atmosphere. Together, two satellites produce a full-face picture of the earth, 24 hours/day. For more information about the GOES project, visit **http://goes2.gsfc.nasa.gov/**

Things began to get complicated as money became less available. Isn't that how it always is? To save $4 to $5 million dollars, we launched a spare earlier than planned, so that we could reduce the number of contractors. It left us with two on-orbit spares. How many spacecraft are you going to have on-orbit before you get criticized for having too many? But we also worried about experienced people being available for the launch, and we were right to be concerned in this regard; thousands and thousands of people have been laid off in the aerospace industry in the past 18 months.

What else did we have to figure into our scheduling? To put it simply: fuel. Eventually, a working satellite runs low on fuel and its usefulness as an operational spacecraft diminishes quickly. We have to retire the satellite or use it for some other function where it is not mainline operational. How long will these satellites continue to perform? Will they go all the way to fuel depletion? I don't know. But you look pretty funny trying to take one out of service that is working well, and you would look even funnier if you put too many of them up and used up their lifetimes orbiting as hot spares.

All this comes into play in the way you schedule the effort to build a spacecraft, to store it on the ground, and then to put it in orbit so that you get it up there before you need it—not knowing when you're going to need it. It's a guessing game and the best you can do is to try to balance all the resources. Here's the average timetable we work with: five years ground storage, two years on-orbit storage, five-year operational lifetime. But what lifetime do you use for a planning schedule? Is it the five years? Or is it an estimate of fuel depletion?

Sometimes you make a schedule that you use for budget purposes to get the money you need, assuming the five-year lifetime, and then anything you get beyond that is gravy. But do you get accused of lying to Congress or Office of Management and Budget when you do that? That's something we face as we do schedules for an ongoing program like this. NOAA can no longer go back and say, "This is what we need," and get all the money they need for satellites because Congress says, "Look, they're working fine. You've solved your problem." Congress isn't planning as far ahead as we need to. If you want to look at a long-term program, this is it. We have launch dates slated through 2021.

What I want to get across here is that when you get a multiple-unit situation like we have in satellites, and you have something like on-orbit performance to evaluate, the scheduling becomes complicated and it requires ongoing attention in order to make adjustments for changing situations.

Periodically we evaluate the health of the on-orbit assets and revise our schedule as necessary. When we make revisions, does it appear to an outsider that we don't know what we're doing? Yes, is the answer. I call this "scheduling in the real world." •

**THE IDEA OF LAUNCHING A SPACECRAFT THE MOMENT IT WAS NEEDED DIDN'T SEEM VERY REALISTIC.**

### Lessons

- Balance best- and worst-case scenarios when scheduling. This may make scheduling more complicated, but it will yield a more realistic, sustainable project timetable.
- If established approaches aren't likely to achieve desired results, challenge the status quo and be willing to take calculated risks.

### Question

*How have you planned for uncertainty on a project?*